

Germany – a Great Place for Knowledge

Engineering

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Germany



Land of Ideas

Engineering in Germany

The engineering sciences are the **vehicle of technological progress** and are currently facing major challenges: electromobility, energy technology or the development of new materials – in order to cope with these tasks new blood is being sought in Germany, especially for the disciplines of mechanical engineering and electrical engineering. These technical sciences are directly associated with the “Made in Germany” seal of approval. Engineers trained in these sciences are sought-after all over the world.

The challenging degree courses in engineering are basically geared towards the demands of real life. Each university is integrated into an **international network** of business enterprises, research institutes and other universities. Everyone involved benefits from this – especially the students, who often write their degree theses in cooperation with partner firms.

With a bachelor's degree it is possible for engineering graduates to **extend their academic skills** in a master's course. Via a multitude of international doctoral programmes they can enter very different and interdisciplinary fields of research.

This magazine is intended to provide an overview of engineering in Germany for **anyone abroad who is interested in studying engineering** or in pursuing academic further training. The main focus is on the disciplines of mechanical engineering, electrical engineering and all the related disciplines, such as automotive engineering, robotics, materials science, photonics, information technology or simulation technology.

The **higher education landscape** and the two main disciplines are presented under the heading “studying engineering”. Foreign students are also given tips on how to get a place at university and the best way to commence studying.

Another section is dedicated to **master's courses** and doctoral studies, in particular in **international post-graduate programmes**. These guarantee special support for foreign students or doctoral students both in issues related to their studies and in general issues.

Finally the **stable and varied career prospects** of engineers on the German labour market are examined. The development which is becoming apparent for the coming years is likely to open up good job opportunities also to foreign graduates and to all foreign students who are considering the idea of staying in Germany after finishing their degrees.

We hope you enjoy reading the magazine!

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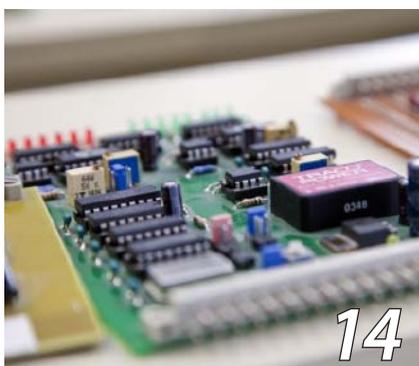
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The art of the feasible

Following initial image problems, engineers have been the key players in the technological environment and the trademark of German technological know-how since the 19th century. The “artists of the feasible” are currently facing major challenges that they wish to tackle with the aid of the latest simulation techniques, the foundations of material science and interdisciplinary systems thinking.



Factories are becoming totally digital: engineers simulate, optimise and monitor production processes with the aid of computer networks, such as here at the Technische Universität München (TUM).

Many historians and engineers are of the opinion that Leonardo da Vinci was the first in a long line of engineering ancestors. In actual fact he, too, bore the title “ingegnere”, which meant in Italian at that time a person who dealt with the maintenance and operation of military instruments. The all-rounder who painted the Mona Lisa and invented the rack and pinion gear comes astonishingly close to the self-conception of many engineers today, as the creative elements of this occupation (lat. ingenium; innate talent, natural capacity) become increasingly prominent. “Today millions of engineers worldwide combine creativity, modern science and craftsmanship to create useful products and sometimes breathtakingly beautiful things,” says Professor Ekkehard Schulz, a member of the Supervisory Board of ThyssenKrupp

(interview on page 7), “in my opinion this makes them artists.”

The rise of engineering

However, the first Corps of Engineers in Germany was developed from an existing Corps of Artillery. In times of peace, the engineer officers worked in hydraulic engineering, road and bridge construction as well as in land surveying and cartography. In 1743 the “Dresden Academy of Engineers” (“Ingenieurakademie zu Dresden”) was founded, where subjects such as mathematics, fortress construction, geodesy, the art of civilian construction, mechanics and the study of machinery were taught. As a result colleges of engineering were founded in German states: “higher colleges of technology” (“höhere technische Lehranstalten”), as the direc-

tor of the Association of German Engineers (Verein Deutscher Ingenieure – VDI), Dr Willi Fuchs, calls them, followed by universities of technology, which were placed on an equal footing with classical universities during the course of the 19th and 20th centuries.



Dr Willi Fuchs is the director of the Association of German Engineers.



High level of practical relevance: in the production and research hall of the TUM students can practise the construction of assembly lines.

The academic qualification of “Diplom-Ingenieur” (Dipl.-Ing.), which is highly regarded throughout the world today, was created in 1899 together with “Dr.-Ing.,” on the occasion of the hundredth anniversary of the Technische Hochschule Berlin in a “highest decree” issued by the King of Prussia. “The right to bestow doctoral degrees in engineering had to be asserted in the face of fierce resistance from the natural sciences and the arts, which did not regard engineering as having an academic rank,” Dr Fuchs, who has a doctorate in engineering, points out.

What the fact that there had been graduates from technical universities and their predecessor institutions since the 19th century meant for Germany’s economic development is described by Professor Walter Kaiser, holder of the Chair for History of Technology at RWTH Aachen University (Rheinisch-Westfälische Technische Hochschule Aachen): “In the German Empire in the late 19th century, industry had obviously



Professor Walter Kaiser is the holder of the Chair for History of Technology at RWTH Aachen University.

reached a level where it could only develop its further potential in civil engineering and mechanical and electrical engineering with the aid of engineers with academic training. Gottlieb Daimler, for example, with his early vision of global motorisation, studied at Stuttgart Polytechnic. Carl Benz was a student at the polytechnic in Karlsruhe. And the fact that Siemens & Halske participated in the high voltage current boom from 1880 onwards was not least thanks to Friedrich von Hefner-Alteneck, who had studied at Munich Polytechnic and at Zürich Polytechnic and turned the experimental dynamo developed by Werner Siemens into a marketable electrical machine.”

The engineer as an innovator

Since that time engineers have thus acted not only as inventors but also as innovators: “Engineers have always gained their impetus from real value added. That means launching an invention on the market successfully, selling it as a product, and also creating jobs,” Dr Fuchs, the head of the VDI, emphasises. In German engineering a practice-oriented view is at work instead of a purely theoretical and scientific view. “Against this background, German engineers are highly regarded internationally in particular for their ability to transform a discovery into a real technical product,” Dr Fuchs knows.

Looking at the past 50 years, however, it can be seen that in many respects engineering has moved closer to scientific research once again. “The work of the modern engineer is characterised in methodological

terms above all by the refinement of physical modelling and numerical mathematics,” Walter Kaiser says, explaining this development, and adds a second aspect: “The fields of activity in which mechanical engineers, electrical engineers and computer scientists work are increasingly permeating each other. This is unmistakable in modern power engineering or automotive engineering: automotive engineers have become technical computer scientists in many cases today.”

Simulation technology as a tool

The computer itself is the central construction and analysis tool in today’s engineering. “Simulations using the computer right through to the use of ‘virtual reality’ have become indispensable,” Professor Kaiser confirms and continues, “Some experiments, such as when testing electrical networks or in aeronautics, frequently cannot be conducted for safety reasons.” Professor Kaiser points out that the computer and appropriate models can make it easier to assess serious technical consequences as early as possible. “Quite apart from the fact that one outstanding and critical aspect of ‘global change’, climate research, basically means high-performance computation.”

The simulation techniques are indispensable not least because technical systems can no longer be realised within a given time frame in any other way. VDI director Dr Fuchs sees a huge potential for reducing costs when the entire procedure is decided before even a fraction of the material has been installed. “Modern Simultaneous Engineering”, technology historian Walter Kaiser adds, “in other words the strongest possible temporal overlap between research and development, the production of prototypes and transition to the product manufacturing phase would be inconceivable without such simulation techniques.”

Totally digital factories

Here experts look into such questions as how entire manufacturing plants can be planned and built in such a way that they constantly work at their economic optimum. Systems for the dynamic simulation of production processes are used for this and are integrated into a continuous planning environment. In this way, for example, the material flow, complex manual assembly procedures or automated production lines and robot operations can be digitally optimised and secured by means of simulation. This also includes fully kinematic human models. Using these virtual models which are transformed into sequences of moving



Simulation tools first have to be developed: two students at the TUM test a driving simulator.

images – both from the perspective of the individual workers and as a wide shot – it is possible to examine processes and motion sequences from an ergonomic point of view and determine the individual process steps and times.

The University of Stuttgart, for example, has recognised the future prospects of simulation technologies in the 21st century and brings together its varied expertise in all fields of modelling and simulation sciences in the Stuttgart Research Centre for Simulation Technology (SRC SimTech). The scientists at SimTech are developing an Integrated Systems Science, thereby creating the basis for simulations and modelling of tomorrow's world. In a specifically developed cooperative doctoral programme the doctoral students at the Graduate School of Excellence advanced Manufacturing Engineering (GSaME) can conduct their research for example at renowned firms in mechanical engineering, electrical engineering and electronics or automotive engineering.

How will the image of the engineer develop against this background in the future? What trends are there besides the virtualisation of planning and construction? "As industry adopts environmental protection as a criterion of production and of the product itself, engineers are increasingly going to have to think and act in ecological terms," says Professor Kaiser, citing another challenge. "Concepts that are oriented towards marketing – from Blue Efficiency through to Clean Technologies – have to be matched increasingly well by the development of the technology on which they are based."

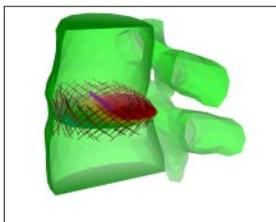
Green thinking in the system

The "green engineer", which has come under public discussion, is not just a cliché, because dealing with energies and materials in a sustainable way occupies a key position more and more often. The fact that reusable materials are expensive and only available to a limited extent has to be taken into account when developing and implementing

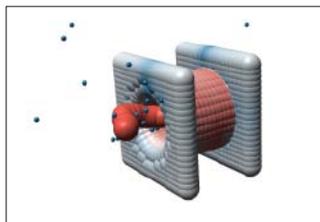
technologies. "Material efficiency is the buzzword that has been adopted into the body of thought of all engineering disciplines," Dr Fuchs says, summarising this aspect.

"Today it is not enough to construct a wind turbine," the VDI director says to explain the situation of engineers, who have to think and act in increasingly complex system contexts. "The logistics of the entire system has to be planned. This includes for example an intelligent network system or researching materials that make it possible to transport energy." All this can only be achieved in interdisciplinary teams. Such teams have been created since the second half of the 20th century in the sphere of what the technology historian Walter Kaiser calls the "typical cross-cutting technologies of microelectronics and information technology". Somewhere between nanotechnology, simulation technology and global communication, however, regional particularities and the customers will also frequently have to be taken into account, for which the engineer has to have a good sense of proportion.

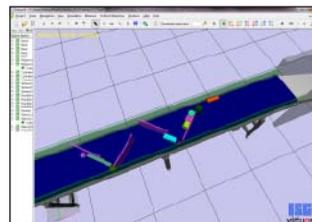
Examples of applications from the SRC SimTech



Biomechanics: simulation of the collagen fibres and the pore pressure in the intervertebral disc while the lumbar spine is tilting backwards



Computational physics: simulation of a coarse-grained model of DNA moving through a pore together with the necessary counterions



Machine control: physics simulation of conjoined transport systems in the real-time control cycle for a virtual start-up of the digital factory

INFORMATION

RWTH Aachen University – Chair for History of Technology (Lehrstuhl für Geschichte der Technik)
www.histech.rwth-aachen.de

Association of German Engineers (Verein Deutscher Ingenieure e.V. – VDI)
www.vdi.de

Stuttgart Research Centre for Simulation Technology (SRC SimTech)
www.simtech.uni-stuttgart.de

Graduate School of Excellence advanced Manufacturing Engineering (GSaME)
www.gsame.uni-stuttgart.de

Interview with Professor Ekkehard Schulz

Good reasons to become an engineer

Ekkehard Schulz was CEO of ThyssenKrupp for 12 years, is an honorary professor of the Clausthal University of Technology and holds honorary doctorates from the Technische Universität Berlin and RWTH Aachen University (Rheinisch-Westfälische Technische Hochschule Aachen). In 2004 he launched the initiative “Discover the Future of Technology” (“Zukunft Technik entdecken”), which aims to fill in particular young people with enthusiasm for technology and science. His book “55 Reasons to Become an Engineer” (“55 Gründe Ingenieur zu werden”) is a passionate plea for what is in his opinion the “most beautiful occupation in the world”.



Is a degree course in engineering only attractive for people who love maths and one that is unpopular with women?

Mathematics is one of the skills that an engineer needs. Without skills in mathematics a student on an engineering degree course will not get any further than the foundation course. However, I do not agree that a degree course with a strong maths

bias such as engineering automatically has to be unpopular with women. Mathematics has long been one of the ten favourite fields of study for women. If we could make all the young women who are confident with figures and formulae enthusiastic about technology, we would already have achieved a lot.

To whom would you recommend a degree course in engineering?

Engineers should be inspired by the idea that everything can always be made better still. I consider inquisitiveness to be important. Also a certain impatience and the willingness to question the status quo. Above all, though, engineers-to-be should enjoy solving technical problems independently. In my case the fascination for the material steel was predominant from the very beginning. For that reason I opted at that time to study metallurgy in Clausthal-Zellerfeld. The more I became engrossed in the subject matter, the more this enthusiasm grew – and it has lasted until now.

Does everyone who has gained an engineering degree in Germany automatically participate in the “Made in Germany” trademark?

“Made in Germany” is a promise that German engineers have honoured time and again for decades. An example: shortly after the start of the new millennium, problems arose with the construction of the Transrapid route in Shanghai. At the time I promised the then Premier Zhu Rongji, “Mr Premier, your planned inaugural run will take place at the turn of the year. You decide whether it should be on 31st December 2002 or 1st January 2003. We will deal with everything else.” When the maiden trip had been completed successfully on 31st December 2002, Zhu Rongji grasped my hand on the red carpet and whispered to me, “Thank you so much!” The thanks applied to the entire team, of course. They had achieved all that was humanly possible under conditions that were often very difficult in order to make the Transrapid float. After projects like that people remember that they can rely on German engineers. Everyone who gains an engineering degree in Germany benefits from this esteem.

55 Gründe Ingenieur zu werden (55 Reasons to Become an Engineer – only available in German):

www.zukunft-technik-entdecken.de/55gruende/

Why is an education in engineering a good investment for the future in any case?

Since 2008 there has been de facto full employment in the engineering sector – only about one in fifty engineers is unemployed. And the demand for engineers is still growing because three out of four engineers on the labour market are now already over the age of 35. By 2020 half of the people working as engineers today will have retired. If Germany’s economy is to maintain its position on the world market, we need a lot of new engineers. All this indicates permanently secure jobs with excellent pay.

What engineers achieve cannot always be seen immediately.

What is your nicest example of that?

I like to refer to the beverage can. You really have to imagine from time to time that the sides of the can are rolled from perfectly normal steel slabs. At the beginning these weigh 30 tons, are two metres wide, ten metres long and up to 20 centimetres thick. It is only after a visit to a steel mill that you can understand what immense forces are necessary to produce tin plate that is only 0.3 millimetres thick from that.

What are the main fields of activity and structures in which engineers will have to act in the near future?

I can only make a guess at that. But I would expect the areas of resource efficiency, energy, materials, mobility and computer science still to be among the most important fields of work for engineers in 50 years time, too.

In your book you write that engineers bear a large amount of ethical and social responsibility. What does that involve?

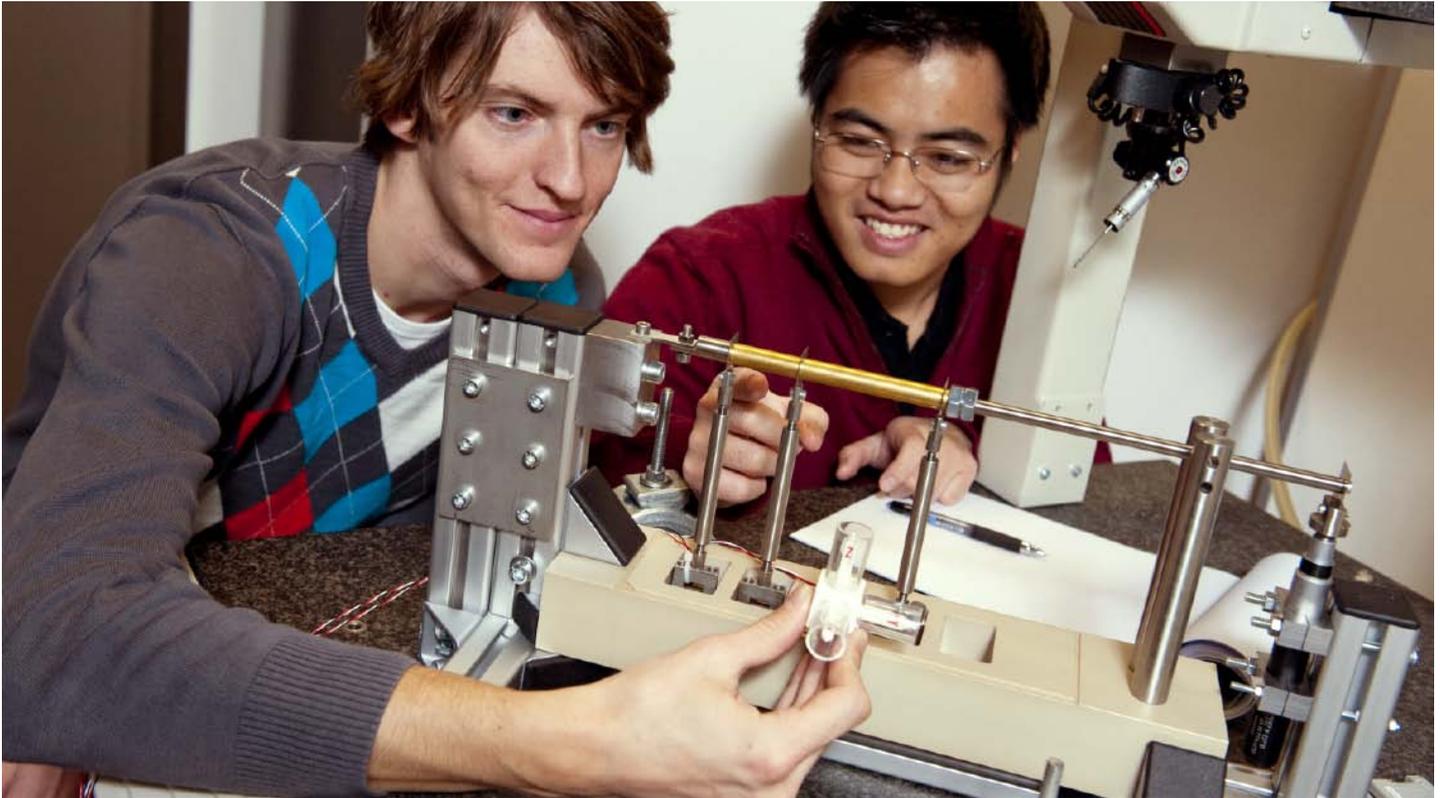
Engineers solve problems using their scientific knowledge and their technical skills. Their solutions have to hold their own not only on the drawing board but also in a reality characterised by incalculabilities. There is only a fine line between what is possible in technical terms and what an engineer can take responsibility for in an environment that is only controllable to a limited extent. Engineers are never detached from the social discussions surrounding the opportunities and the dangers of individual technologies. We only have to think of the debate surrounding the switch to renewable energy sources.

Why would you choose engineering as an occupation again?

Because an engineer’s work never becomes routine: every solution raises new questions that have to be answered. That is what makes this occupation so appealing to me.

Shaping the future with technology

In many fields engineers trained at German universities are guarantors for the technological leadership of German industry in the global competition. Engineering degrees “Made in Germany” rightly have an excellent reputation internationally, because they provide tomorrow’s engineers with superb conditions for studying and for research. These include the outstanding technical facilities at the universities, the intensive cooperation with business enterprises and the incorporation of the universities in a network together with national and international scientific organisations.



Students of engineering try out their skills as early as possible – an interest in technology is therefore a prerequisite.

There is hardly any other field at German universities that is as diversified as engineering. With almost 427,000 students, engineering is the third largest field of study in numerical terms after the field of law, economics and social sciences and the field of languages and cultural studies. Some 126,000 freshman students (including about 20,000 foreign students) enrolled for one of the numerous engineering courses in the winter semester 2010/2011.

Varied and interdisciplinary

The multitude and variety of degree courses does not make selection easy: in addition to the “classic” engineering disciplines such as mechanical engineering, electrical engineer-

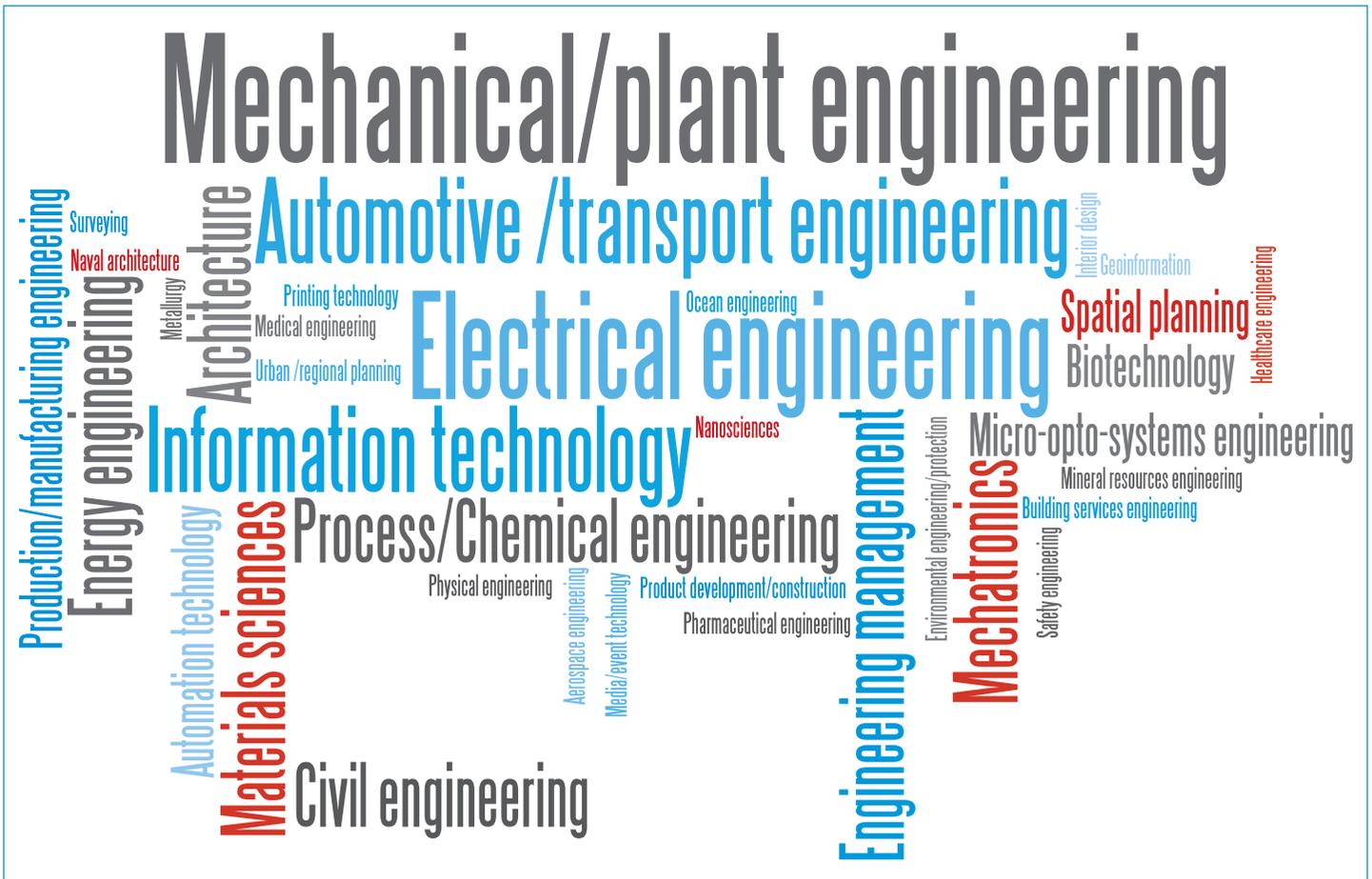
ing or civil engineering, prospective students find a very broadly differentiated range of courses, many of them interdisciplinary in nature. Besides the sound technical training, which takes into account the requirements of developing technology in a way that is environmentally and socially acceptable, the engineers-to-be also acquire the necessary soft skills, which prepare them well for the constant changes in this occupation and for a broad and increasingly international spectrum of activities.

Anyone interested in studying engineering should therefore have excellent school marks in mathematics, physics and chemistry as well as an interest in technology. An ability to think independently and analyti-

cally is the ideal basis. Creativity, good powers of observation and communication skills make the prospects for a career in engineering perfect. Good German language skills are essential in order to be able to follow the lectures. Good English language skills are also required for reading specialist literature, much of which is written in English.

Traditional university or university of applied sciences

The spectrum of possible disciplines and special focuses in engineering is broad, whereby the disciplines are generally equally represented at the traditional universities and the universities of applied sciences.



Degree courses in engineering (a selection)

Engineering degree courses have been converted to the bachelor's and master's system in Germany in the past few years. The previous "Diplom-Ingenieur" degree can therefore generally no longer be acquired.

What characterises engineering degree courses at **traditional universities** is their clearly specialist and research-oriented focus, though the reference to applications remains constantly visible. The broad spectrum of subjects offered by the universities permits interdisciplinary connections in teaching

and research which cross subject and faculty boundaries. A close research network and intensive cooperation with universities at home and abroad, with non-university research institutions and with numerous companies provide diverse opportunities for students to help to shape research themselves. The nine leading institutes of technology in Germany have combined to form the "TU9 association" ("TU9-Verband").

At the **universities of applied sciences (Fachhochschulen)** the specific reference to

practice and applications of the engineering methods and skills is more prominent. This is expressed, for example, in the generally obligatory internship which has to be completed outside the university in the fifth semester of studies, for example in a craft business or industrial firm. The universities of applied sciences frequently have degree programmes which combine the engineering degree course with an apprenticeship in a firm-based training occupation, thus leading to another vocational qualification besides the degree.



» I have always been interested in the manufacturing of technical products and that is why I wanted to study mechanical engineering. I chose Germany because friends advised me to do so, but also because the country is well-known for its top-quality technology. It is very important to learn the language well. That is the only way to get to know your fellow students easily and to make best use of the support provided by the teaching staff. «

Bertrand Tchana comes from Cameroon and is studying mechanical engineering at the Fachhochschule Südwestfalen, University of Applied Sciences.



»» My first encounter with the TU Darmstadt came about via the DAAD WISE programme in 2009 during my bachelor's degree in materials engineering in India. With the research scholarship I was able to do a research internship here in the Advanced Thin Film Technology Division for a whole summer. My materials engineering research here in Darmstadt focuses on the development of modern storage media. I am currently working as a doctoral student in the field of thin film and oxide nanoelectronics in the group supervised by Professor Lambert Alff. In the long run I aim to become self-employed. Germany provides me with the perfect platform for that. At the TU Darmstadt we have a project called "Unitechspin", which supports technology spin-offs from within the university and new business start-ups and provides them with orientation assistance. ««

Vikas Shabadi comes from India and is studying in the Advanced Thin Film Technology Division of the Technische Universität Darmstadt.

Structure of studies

In the first semesters of their studies the students at all types of university acquire the necessary basic knowledge of mathematics, the natural sciences and engineering. The teaching of specialist and methodological skills in the specific engineering discipline is

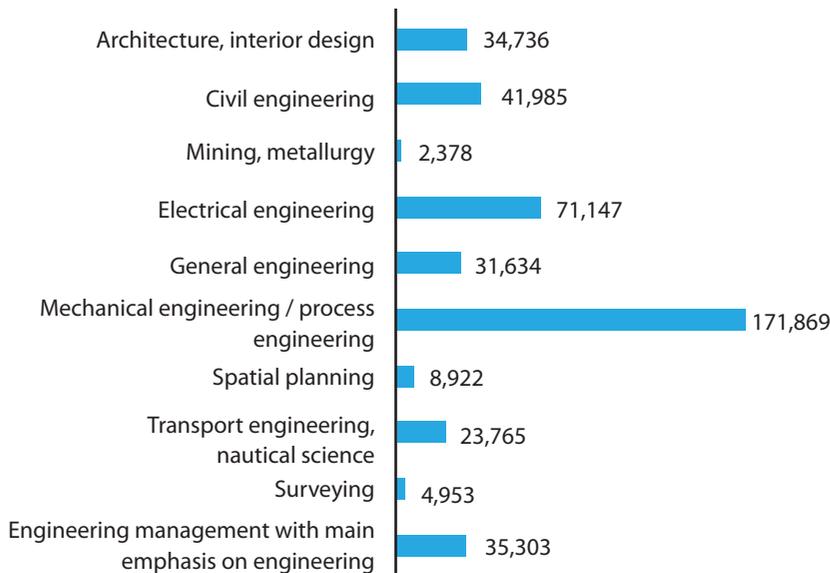
then based on this knowledge. Depending on the degree course different aspects can often be emphasised, thereby creating a qualification profile geared towards the student's personal inclinations. In the context of projects or the bachelor thesis, interesting engineering questions and problems from the fields of

application and research are dealt with, often also in cooperation with companies.

Practical experience as a plus point

Practical skills are highly valued by subsequent employers. In order to be able to put into practice the theoretical knowledge

Number of students in engineering winter semester 2010/2011



Source: Statistisches Bundesamt (Federal Statistical Office), Studierende an Hochschulen Wintersemester 2010/2011, Wiesbaden 2011



Basic knowledge is built up above all during the first four semesters in engineering. That means learning, in groups or alone.

acquired during the degree course later on in the business world, it is very useful to gather practical experience early on. For this reason, especially at the universities of applied sciences, internships in firms lasting several months are an integral part of the engineering degree. However, also voluntary periods of work experience in industry during the university holidays, project work or the selection of a subject for the degree thesis are all good opportunities to establish contacts with firms and to organise the degree course with a practical relevance.



Metrology lab, cleanroom or CAD systems – engineering students have enough opportunities to put their theoretical knowledge into practice.

INFORMATION

Higher Education Compass of the German Rectors' Conference (Hochschulkompass der Hochschulrektorenkonferenz – HRK)

Information about higher education opportunities, universities and colleges, doctorate opportunities and international cooperations with German higher education institutions
www.hochschulkompass.de

THINK ING.

is an extensive information and communication platform provided by GESAMTMETALL • Gesamtverband der Arbeitgeberverbände der Metall- und Elektro-Industrie e.V. (the federation of German employers' associations in the metal and electrical engineering industries) on the subject of engineering occupations in Germany.
www.think-ing.de

uni-assist

Internet portal of the University Application Service for International Students (Arbeits- und Servicestelle für ausländische Studienbewerber)
www.uni-assist.de

www.daad.de/admission

This page provides information about which educational certificates obtained outside Germany are required for admission to higher education in Germany.

A place at university in Germany – admission restrictions, application, admission

There are local admission restrictions for about half of the bachelor's degree courses in engineering in Germany. When selecting applicants the universities can take into account not only the average mark of the qualifications entitling the applicant to go to university but also other criteria, for example grades in certain subjects, the results of an interview, a vocational qualification gained before applying to university etc. What is also important is the waiting period for a university place. It is frequently only possible to begin a degree as of the winter semester.

For admission to universities of applied sciences the applicant generally has to provide proof that he or she has completed periods of work experience lasting several weeks and related to the chosen degree subject by the start of the degree course at the latest. Periods of vocational training, internships or periods of work experience in the student's home country can be recognised for this.

University applicants from outside Germany who fulfil the basic requirements for starting a degree course at a German university generally apply directly to their preferred university, which will inform them about admission requirements for the degree course. For a number of universities, applications have to be submitted via the University Application Service for International Students, **uni-assist**. You can find details about the member universities and detailed information about the application procedure at www.uni-assist.de.

In general the application for admission to an engineering degree course must have arrived at the relevant university by 15th July for the winter semester and by 15th January for the summer semester. The application deadlines may differ from this depending on the university, however. The application deadline for the winter semester at the universities of applied sciences in Bavaria, for example, is 15th June.

Anyone interested in postgraduate studies (Master, PhD) also applies directly to the university or to uni-assist.

Interview with TU9 president Professor Ernst Schmachtenberg

Engineers “Made in Germany”

Professor Ernst Michael Schmachtenberg has been the president of RWTH Aachen University since 2008 and the president of TU9, an alliance of the leading institutes of technology in Germany, since 2010.



Every year some 16,000 international students start an engineering degree in Germany. What can the institutes of technology offer them?

An education in engineering “Made in Germany” is of the highest quality. Studying at an institute of technology (Technische Universität – TU) in Germany is characterised by close research cooperation between the TU and industry. The students benefit from teaching which is

practically relevant and qualifies them to conduct research. As a result of research cooperations and technology transfer they can already gather practical experience in industry and establish contacts for their subsequent working lives during their degree courses. In this way the institutes of technology create excellent conditions for a successful career start.

What requirements should international applicants for places on engineering degree courses ideally fulfil?

For successful studies they should possess in particular inquisitiveness, creativity, communication skills, the ability to work in a team and the ability to think independently. A talent for mathematical and scientific tasks is an important prerequisite. Good marks in mathematics and physics are therefore a first indication of a particular suitability for engineering subjects. We recommend prospective students from abroad to complete the TU9 Self-Assessment. If the international applicants then also have good German language skills, so much the better.

How important is “internationality” at the TU9 universities?

The universities in the TU9 alliance have always had a strong international orientation: our universities offer some 70 master’s courses in engineering, the natural sciences, mathematics and information technology in English, from A for “Automotive Engineering” to W for “Water Resources and Environmental Management”. The proportion of international students at TU9 universities is up to 20 percent in some cases. The close and strategic cooperation with partner universities throughout the world facilitates an intensive exchange of experts and research.

The TU9 universities are regularly present at international education fairs. Why is a visit worthwhile?

Last year alone we went to 26 cities around the world to try to attract talented people interested taking a degree course: whether in Beijing or Buenos Aires, in Moscow or Hanoi – TU9 provides information about studying at the member universities in personal conversations on almost every continent. Anyone who wants to become an engineer or a scientist is invited to obtain information about the opportunities from our specialists locally in a face-to-face conversation.

What characterises an engineer “Made in Germany”?

Engineers “Made in Germany” are highly qualified and versatile: they can be deployed in research, in construction and production, in the service for complex technical systems. Environmental protection, a sustainable energy supply and forward-thinking water management are inconceivable without engineers. In a nutshell: our engineers are able to solve the great challenges of our age as a team.

INFORMATION

TU9

is the alliance of the leading institutes of technology in Germany: RWTH Aachen University, TU Berlin, TU Braunschweig, TU Darmstadt, TU Dresden, Leibniz Universität Hannover, Karlsruhe Institute of Technology, TU Munich, University of Stuttgart.

www.tu9.de

TU9 project “German Schools Abroad – Network for Former Pupils (“Deutsche Auslandsschulen – Netzwerk für Absolventen” – TU9 DANA)

The project promotes a network of students who have come from German schools abroad. The aim is to provide international students at the TU9 universities with excellent support which is tailored to their needs and to continue to improve the degree success rate. Contact can be made via the Internet portal: www.tu9.de/DANA

SelfAssessment international

Foreign prospective students who are interested in studying at one of the TU9 universities in Germany can test their personal aptitude for undertaking technical studies, from home on the Internet. In German or English they have the possibility to familiarise themselves with the access requirements for the technical degree courses. The participants receive detailed feedback about their strengths and weaknesses. A short German test is also available to give students a rough assessment of their language skills. The entire test takes about 90 to 120 minutes and is free of charge.

www.self-assessment.tu9.de

A number of other universities also offer self-assessments as practical guidance.

Mentoring

Bridge to Studies

Subject-specific preparatory courses on the one hand and inter-faculty integration courses on the other hand – there are lots of such courses at German universities. The pilot project “Bridge to Studies” combines the two types. During the one-year preparatory course foreign prospective students get to know the German language and culture and acquire technical and methodological skills.



The participants in the mentoring programme complete a one-year joint preparatory course. Requirements: basic German skills and a qualification entitling the applicant to enter higher education

In preparatory courses basic knowledge is built up. Prospective engineering students can extend in particular their mathematics skills in these courses run by the German universities. Integration programmes are aimed above all at foreign students in order to enable them to settle down in Germany more easily. The “Bridge to Studies” preparatory courses for applicants to bachelor’s and master’s degree courses at Lausitz University of Applied Sciences, Brandenburg University of Technology in Cottbus and the Technical University of Applied Sciences in Wildau cover both of these aspects.

“The programme is interesting in particular for people whose German language skills are not yet good enough for higher education studies,” Thomas Reiff, head of the project, emphasises. An intensive German language course can remedy this. However, that is by no means everything: “A whole year learning German, acquiring key skills

relevant for studying and trying out normal everyday life at university,” Thomas Reiff says, summarising the components of the scheme.

Owing to the technical orientation of the participating higher education institutions, the preparatory year is attractive above all for prospective students of engineering. The teaching focuses mainly on scientific and technical topics. Depending on which degree course the student is interested in, the participants can take preparatory courses in mathematics, chemistry or physics.

Integration by exchanging experiences

Project coordinator Michael Männel sees the intensive support of the participants as the biggest advantage: “Teachers and mentors answer questions regarding the planning of the degree course at any time.” Exchanging experiences is encouraged in the intercultural tandem partnerships at Lausitz UAS:



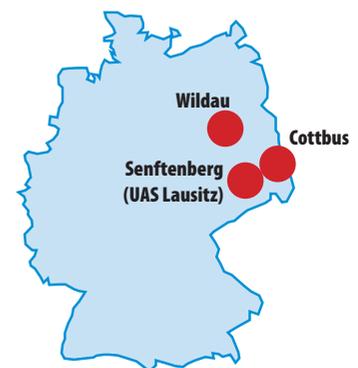
» My experiences with the “Bridge to Studies” programme are very good: I got to know the higher education system and learnt technical German. Together with lots of international students I gained additional skills for studying, such as scientific working skills and intercultural competence. For me this was an important step before starting my degree course. «

José Manuel García Sánchez comes from Mexico and is in his first semester of a degree in biotechnology at Lausitz University of Applied Sciences.

each foreign freshman student is mentored by a German student or another international partner.

The students can make new friends on excursions and tours of the university and the town. “We want the participants to feel good and be happy to start a degree course at the university,” Thomas Reiff and Michael Männel, the two project managers, explain. For example, the organisation of leisure activities, such as international cooking evenings or barbecues, is supported.

The successful outcome after the first year of the project speaks for itself: all of the degree course applicants from Azerbaijan, China, Mexico, the USA and Russia passed the qualifying examination and enrolled for the bachelor’s or master’s degree courses of their choice at one of the universities.



INFORMATION

Bridge to Studies (Brücke zum Studium)

www.bruecke-zum-studium.de

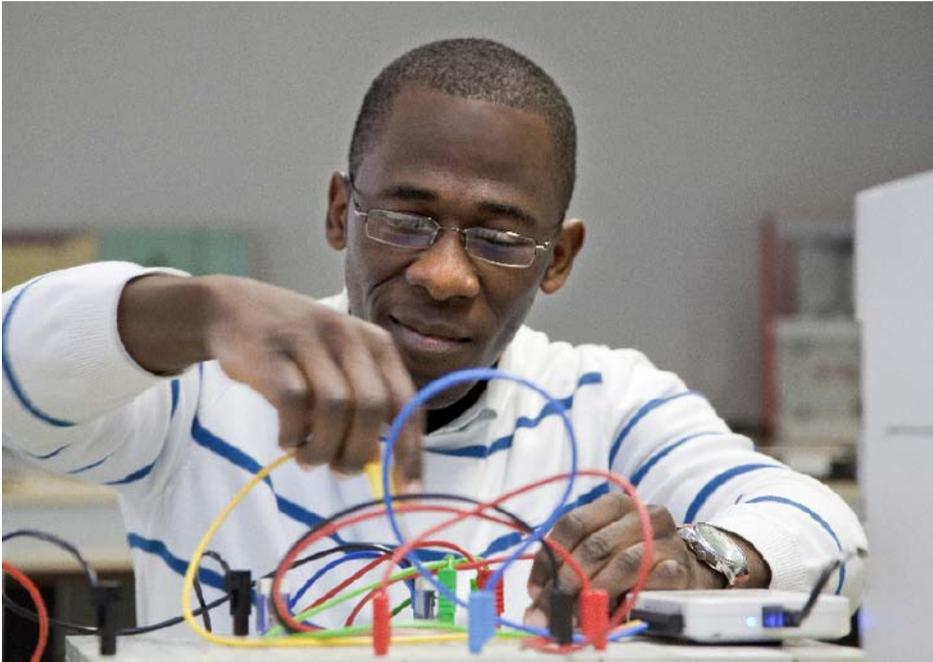
Preparatory courses

At www.study-in.de prospective students can find information about the many preparatory courses (Studienkollegs) and introductory courses (Propädeutika) offered at German institutions of higher education:

www.study-in.de > Study > Preparatory and Introductory Courses

An electrifying degree course

With some 1,350 students, the department of "Electrical Engineering, Precision Engineering and Information Technology" at the Georg Simon Ohm University of Applied Sciences in Nuremberg is one of the largest of its kind in the whole of Bavaria. The Ohm University of Applied Sciences is named after the world-famous physicist who discovered electrical resistance, Georg Simon Ohm, who was rector here from 1839 to 1849. Whether a traditional university with a focus on research or a university of applied sciences, at virtually all university locations in Germany, like in Nuremberg, young electrical engineers who will help to shape the future of the major technologies at home and abroad are trained.



A degree course in electrical engineering does not just consist of theory: in the metrology lab the students learn how to operate the measuring instruments and to use the correct approach for measurement processes.

Electrical Engineering and Information Technology – just a degree course for boffins who never put down their soldering irons? "Not at all," says Professor Bruno Lurz from the Georg Simon Ohm University of Applied Sciences and makes it clear, "It is about future technologies, and they demand innovative and competent people who develop new ideas and put them into action." Professor Lurz is the course advisor in the Department of Electrical Engineering, Precision Engineering and Information Technology and knows the questions and problems that the students have, especially in the initial semesters. "Electrical engineers require a solid basic knowledge of mathematics and the natural sciences. In addition they need information technology and programming skills. Learning all this means working at least 40 hours per week, you just have to struggle through," as the course advisor well knows.

That is also what Patrick Ninzeko Tsapi did. The 25-year-old from Cameroon has

been studying "Electrical Engineering and Information Technology" in Nuremberg since the winter semester 2008/2009. "At the beginning it really wasn't easy. Because I couldn't speak German very well yet, I didn't understand everything in the lectures. I went to the library afterwards, looked up the subject matter straight away or asked the professors," he remembers. He was obviously very successful, for shortly afterwards he was already working as a tutor, explaining the basics of electrical engineering to younger fellow students. "Initially seven students came to my tutorial, these days 20 come," he explains and presumes that this is due to positive word of mouth.

Laboratory training

Degree courses at a university of applied sciences aim to impart application-oriented skills on a scientific basis. Studies at the Georg Simon Ohm University of Applied Sciences therefore become increasingly

practice-based after the more theoretical basic semesters. "A total of 34 modern, well-equipped labs are available at the Department of Electrical Engineering, Precision Engineering and Information Technology for teaching and applied research and development," Norbert Weigand, who looks after the metrology lab, reports. "Here the students learn how to work precisely and to use the correct method for measurement processes. In addition they experience that everything does not always run according to the textbook, but that interfering factors can distort the series of measurements. The students also practise how to operate the measuring instruments, such as an oscilloscope, and the metrology software," Weigand says, explaining the practical benefits of the lab work.

Internships

One important element of a degree course in electrical engineering is the internship semester in industry, which takes place in the fifth semester in Nuremberg. Patrick Ninzeko Tsapi did his internship in a local industrial enterprise in the nearby town of Erlangen, working intensively on a circuit diagram for the emergency shutdown of generators: "I learnt a lot during my internship; it really motivated me." An assessment that Professor Lurz can also confirm: "During their internships the students experience how they can actually apply the knowledge they have acquired. This gives many of them a real boost."



Patrick Ninzeko Tsapi comes from Cameroon and is studying electrical engineering and information technology at the Georg Simon Ohm University of Applied Sciences in Nuremberg.

Professor Bruno Lurz advises the students of electrical engineering and information technology at the Georg Simon Ohm University of Applied Sciences in Nuremberg.



He also points out another benefit of the internships: "Contacts are often established there which can be useful for the bachelor thesis and for the time after graduation."

Even though a degree course in electrical engineering at a university of applied sciences is quite strictly organised compared with a course at a traditional university, there is still enough scope for the students to focus on a field that they find interesting. Patrick Ninzeko Tsapi chose "Electrical Energy Engineering" for his specialisation in the sixth and seventh semesters, which is one of a total of six specialisation options in the portfolio of the university of applied sciences in Nuremberg. "Think of the possibilities of meeting Europe's electricity needs using solar energy from Africa. There are still very, very many

problems to solve," the young student says, commenting on his choice of specialisation.

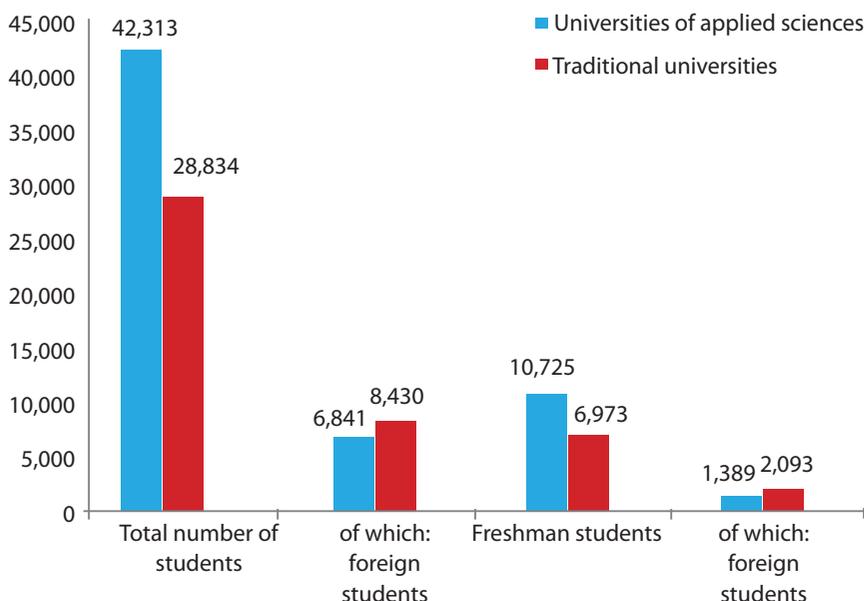
At most universities it is possible to choose a specialisation: automation engineering, energy engineering, automotive electronics, information and communication technology, measurement, control and regulation technology, microsystems and precision engineering, renewable energy systems, robotics, sensor technology or telecommunications are just a few of them.

Cooperation with industry creates a win-win situation

Patrick Ninzeko Tsapi is currently working on his bachelor thesis. He is dealing with the question of how the characteristics of electrical components change when they are

exposed to gamma radiation such as occurs, for example, in nuclear power plants. The work is being supported and supervised by the industrial company where he did his internship semester. "About 80 percent of our final theses are written in cooperation with industry," Professor Lurz, the course advisor, explains and adds, "From the topics selected we are also able to see what specialist issues the industry is currently dealing with. That helps us to adapt our syllabus to actual demand." Patrick Ninzeko Tsapi wants to graduate at the end of March 2012. "If I get a good job offer, I would like to work as an engineer at first and gather experience. Maybe I'll do a master's degree later on," he says, looking into the future.

Students of electrical engineering and information technology winter semester 2010/2011



Source: Statistisches Bundesamt (Federal Statistical Office), Wiesbaden 2011



INFORMATION

Georg Simon Ohm University of Applied Sciences

www.ohm-hochschule.de

Association of the Electrical Engineering and Information Technology Faculties (FTEI)

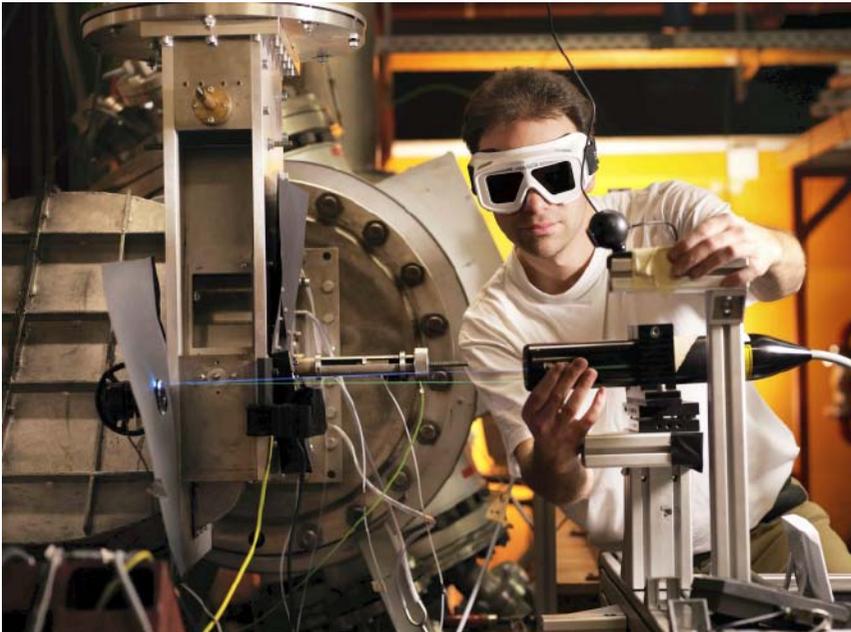
www.ftei.de

Association of Electrical and Information Engineering Departments (FBTEI)

www.fbt-et.de

From a classic degree to a quick-change artist

No other field of studies at German universities is so multifaceted as mechanical engineering. The classic degree course has transformed into some 317 bachelor's degrees and 175 master's degrees with different profiles and specialisations – with many facets including construction engineering, precision engineering, process engineering, automotive engineering, materials engineering, power engineering and production engineering. With its focus on forward-looking technologies the Karlsruhe Institute of Technology (KIT) creates optimal conditions for a successful career start in research and industry with its broadly based course.



A student of mechanical engineering is setting up a thermal turbomachine (left); his fellow students have gathered in the KIT library (top).

The dynamic economy, the attractive labour market and the high quality of life in Germany were crucial factors for Etienne Boisseau's decision to start a degree course at the KIT. His foreign language skills were also relevant for the decision: "As German was my first foreign language and I have a German-French 'Abitur' qualification, I was certain from the very beginning that I would go to Germany." Together with almost 3,400 fellow students, Etienne Boisseau is currently studying at the Department of Mechanical Engineering. Like him, 20 percent of the mechanical engineering students are from abroad.



Etienne Boisseau comes from France and is studying mechanical engineering at the Karlsruhe Institute of Technology.

Mechanical engineering is offered as a consecutive course at the KIT. In this way the basic scientific skills acquired in the bachelor's course can be consolidated in the application-oriented electives in the connected master's course. For Professor Martin Gabi, the former dean of the Department of Mechanical Engineering and currently head of the Institute of Fluid Machinery, the advantage of the consecutive degree course is obvious: "It is the best opportunity to study a self-contained curriculum. Although the bachelor's degree is an important half-way point, the regular qualification is the master's degree."

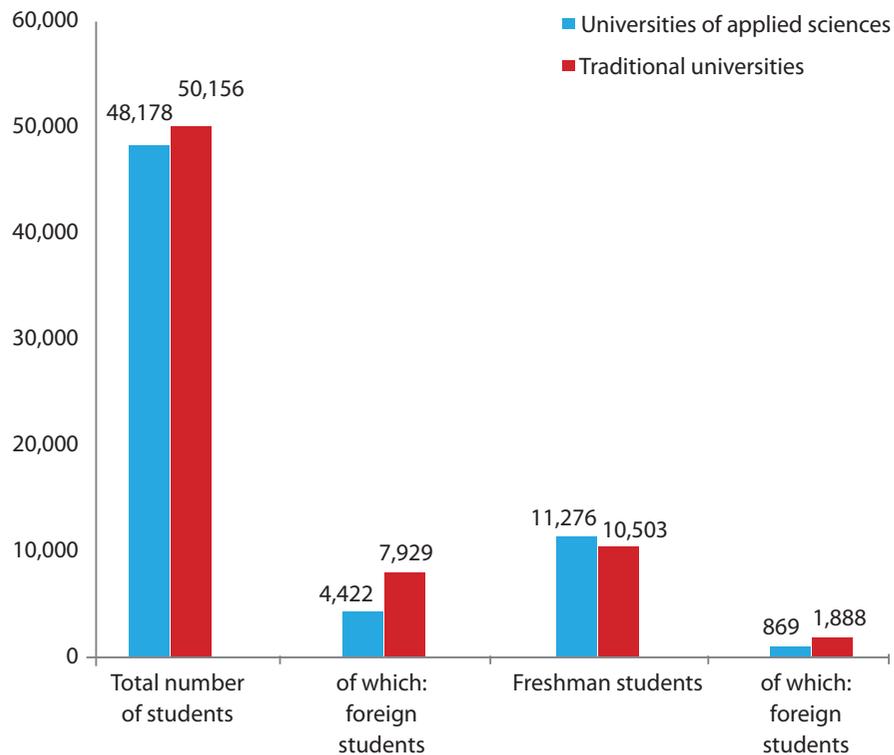
German-French degree

Etienne Boisseau's home university, "Arts et Métiers ParisTech", and the KIT offer several dual degree programmes in the context of a higher education partnership. In these programmes groups of German and French students study together from the fifth semester of their bachelor's degree courses onwards. Each student completes three semesters and an industrial internship abroad.

Unlike students spending one or two semesters studying abroad via the EU education and training programme, ERASMUS international students like Etienne Boisseau can study abroad for up to two years and gain a binational double degree in addition: "After the consecutive bachelor's-master's course at the KIT I will gain the internationally recognised 'Master of Science', the 'Diplom-Ingenieur' and the 'Diplôme d'Ingénieur' qualification which is established in France."

"The dual degrees have the big advantage that the achievements at the higher education institution and in the students home countries are recognised as equivalent," Professor Gabi says, emphasising one of the important advantages of the binational degree course. Besides France, there are partnership programmes with South Korea, the USA and Bulgaria. "As internationality plays an important role at our institution, we want to expand this offer further, for example in China and South America," Professor Gabi reports, speaking about the current plans of the institute in Karlsruhe.

Students of mechanical engineering winter semester 2010/2011



Source: Statistisches Bundesamt (Federal Statistical Office), Wiesbaden 2011

Deciding your direction yourself

"In contrast to the French 'grandes écoles d'ingénieur' system, in which the degree course is highly structured with respect to content and organisation, in Karlsruhe I am responsible for what I study myself," Etienne Boisseau knows from his own experience. Whether product development and construction, energy and environmental engineering, mechanics, thermodynamics or materials for high-performance systems – the student of mechanical engineering values the varied courses on offer at the KIT and the resulting options: "This means that I can decide the direction of my studies myself."

Etienne Boisseau has not yet chosen a topic for his bachelor thesis. At the Insti-



Professor Martin Gabi is the head of the Institute of Fluid Machinery at the Karlsruhe Institute of Technology.

tute of Product Development (Institut für Produktentwicklung – IPEK) of the Department of Mechanical Engineering he is spoilt for choice at any rate. The IPEK provides the opportunity to test new technologies and to choose one of the many exciting research projects. "The students simulate the entire product development process, starting with the initial idea and going right through to its production. And in the process they learn all the relevant aspects of project management such as budget planning or staff organisation," Professor Gabi explains.

The professor of mechanical engineering is grateful for the financial support from large corporate groups and medium-sized companies, which make projects of this kind possible. "Our cooperations with companies ultimately constitute the economic basis of the department for conducting research on a high level." Thanks to the financially strong economic partners, the institute's equipment includes a robot factory of its own and a 3D scanning vibrometer for non-contact measurement of surface vibrations.

One degree – lots of opportunities

Professor Gabi predicts that the graduates will have a successful future: "At the KIT students of mechanical engineering acquire not

only the mere ability to apply methods, but also the competence to develop engineering processes. In this way we prepare our graduates perfectly for managerial positions in an international environment and are proud when they promote innovations in industry later on."

Etienne Boisseau, too, wants to get off to a flying start as a driver of innovation after graduating and has recognised the importance of the interdisciplinary work: "I want to acquire a broad specialist knowledge and eventually be able to link different fields together, for example as a project manager."



INFORMATION

Karlsruhe Institute of Technology (KIT) – Department of Mechanical Engineering

www.mach.kit.edu

KIT DeFi – German-French Initiative at the KIT (Deutsch Französische Initiative im KIT)

www.defi.kit.edu

IPEK – Institute of Product Development at the KIT (Institut für Produktentwicklung am KIT)

www.ipek.kit.edu

International double degrees at German higher education institutions

German higher education institutions cooperate with many partner institutions of higher education all over the world. In the context of these partnerships there are frequently double-degree or joint-degree programmes. It is often worth enquiring at your own university or college about any existing cooperation agreements.

At www.daad.de/international-programmes > Advanced search options > Joint Degree Programme you can search for engineering courses leading to a joint degree.

Master's – a springboard, Dr.-Ing. – a recipe for success

For numerous young engineers working life begins straight after graduation. However, many graduates wish to expand their skills further on an academic level before starting their careers and begin a master's degree or work towards a doctorate. They can find attractive options for this, too, at the German universities.



Engineering also includes basic research, for example in nanotechnology when material properties are to be designed at molecular level.

From “Automotive Engineering” to “Water Resources and Environmental Management” – in the field of engineering there are currently about 1,250 master's courses to choose from at universities of applied sciences and traditional universities. Many of them are taught in English. Some 3,800 international students began a master's degree in engineering at a German higher education institution in 2009.

Master's degrees – extending present knowledge or learning something new

Master's degrees, which generally last three or four semesters, can be more “application-oriented” or more “research-oriented” in character and serve as a method of technical and scientific specialisation. The degree course need not necessarily be restricted to

the specialism of the first degree, but can focus on a related discipline or tap into a completely new domain. It can be started immediately after gaining a bachelor's degree or later on after a period of employment. The specific admission requirements, such as above-average grades in the examinations for the first degree or certain specialist skills and work experience, are laid down by the university. A master's degree in engineering leads to the qualification “Master of Engineering” or “Master of Science”.

A master's degree is frequently the starting point for an academic career at universities. “If, for instance, a foreign student completes his or her master's degree in an engineering or science subject with a good or excellent result, he or she would be well advised to follow it with a doctorate,” advises

Professor Ernst M. Schmachtenberg, president of TU9.

Individual or structured doctoral studies

As places of cutting-edge scientific research, universities and renowned non-university research establishments in Germany offer engineers with a strong interest in science an exceptionally broad range of opportunities for independent academic work. About 2,600 engineers gained a doctorate from a German university in 2010. In addition to the traditional model of doctoral studies, where the doctoral students themselves look for a doctoral supervisor to supervise their work, gaining a doctorate via a structured doctoral programme or at a graduate college is gaining popularity. There the universities include the doctoral students in the research process



» Following positive experiences during my two-year master's degree course in "Computational Mechanics" at the Technische Universität München I was highly motivated to continue researching at this renowned university as a doctoral student. The subject of my doctorate is conceived as a joint project involving the IGSSE (International Graduate School of Science and Engineering) at the TUM and an industrial partner. I therefore had the opportunity to work on a research topic with application potential for industry. In addition to that I was able to gather valuable experience as a result of the cooperation with international scientific partners. I was able to build good relationships with my colleagues and make good friends in Germany. «

Jason Papaioannou (Diplom-Ingenieur) comes from Greece and is working towards a doctorate at the TUM in the research project "Hydroelastic analysis of very large floating structures".

intensively at an early stage and guarantee intensive support.

Programmes of this type include

- doctoral programmes at universities,
- Research Training Groups of the German Research Foundation (Deutsche Forschungsgemeinschaft),
- graduate schools at universities,
- Helmholtz International Graduate or Research Schools and
- International Max Planck Research Schools.

Doctorate in engineering in industry

Universities and research institutions often cooperate at regional level with industrial

firms. Engineers who are working towards a doctorate are involved in joint research projects and deal with questions from industrial practice. In addition they gain diverse skills which serve as the basis for a rapid rise to managerial positions in industry.

"The state-of-the-art technology in Germany and the economic power of industry here are connected to a considerable extent with doctoral work in engineering," Professor Schmachtenberg, president of TU9, emphasises. "Outstanding scientific achievements and the links with the issues of industry are the recipe for success!"

As most of the funding for conducting the research projects is obtained from outside the institutions, for example as third-party funds from industry, the doctoral students are paid, which makes it possible to carry out the doctoral research quickly.

After gaining their doctorates the young scientists are then pleasantly spoilt for choice. They can either go into industry or, for example, take up a post-doctoral position. "That may be at a university or at a non-university research institution. There are plenty of opportunities if you have a German 'Dr.-Ing.' title on your C.V. at any rate," Professor Schmachtenberg knows from his own experience.



In the Process and Chemical Engineering department of the Institute of Multiphase Flows at Hamburg University of Technology research is conducted into "increasing energy efficiency and reducing greenhouse gas emissions by means of the multi-scale modelling of multiphase reactors". The photo shows a bubble column reactor in which liquid and gaseous substances can be combined.

INFORMATION

DAAD – International Programmes in Germany

On the website of the German Academic Exchange Service (Deutscher Akademischer Austauschdienst), you can search for internationally recognised, accredited bachelor's, master's and doctoral programmes in engineering, most of them taught in English. All the programmes offered in the database ensure special course-related and personal support for students and doctoral candidates from abroad.

www.daad.de/international-programmes

You will find a list of postgraduate courses related to development at:

www.daad.de/entwicklung

- > Information for Students and Alumni
- > Postgraduate Education
- > Postgraduate Courses

Further links

to find out about the programmes offered for graduates and postgraduates:

www.hochschulkompass.de

German Rectors' Conference (Hochschulrektorenkonferenz – HRK)

www.tu9.de/graduierete

Overview of the doctoral programmes, graduate colleges, graduate schools and English master's courses at the TU9 universities

www.dfg.de

German Research Foundation (Deutsche Forschungsgemeinschaft - DFG)

www.research-explorer.dfg.de

The Research Explorer of the DAAD and the DFG

www.helmholtz.de

Helmholtz Association

www.mpg.de

Max Planck Society

High technology for sustainable mobility

Intelligent driver assistance systems, effective engine management or alternative drive concepts – industry and research institutions in Germany are working flat out to find forward-looking technical solutions. The universities prepare the future engineers perfectly for the associated challenges, ensuring that people and markets remain mobile in the future too.



Cars consist of 60 to 70 computers and a lot of electronics systems. These are tested thoroughly in reference vehicles.

Slightly away from the large metropolises but still right at the heart of Europe's automotive industry, students at Esslingen University of Applied Sciences can participate directly in the innovation activity in automotive engineering. For Basti Anil Shenoy from India, too, this was one reason why he enrolled on the master's course in "Automotive Systems" in September 2010. "The location of the university, close to Stuttgart, makes it easy to establish contact with numerous automotive companies and suppliers in the surrounding area."

The many years of close links between the university and automotive companies in the region, including such global players as Audi, Daimler and Porsche or suppliers such as Behr, Bosch or Eberspächer, ensure that the degree courses have a strong practical relevance. "We are supported in our teaching by lecturers from industry, and advisory boards from industry provide us with advice on developing our degree courses. The students benefit from the resulting practice-oriented

topics," Director of Studies, Professor Erich Schindler, emphasises.

Specialists with an eye for the whole works

Esslingen University of Applied Sciences offers "Vehicle Dynamics" and "Car Electronics" as major fields of study. Basti Anil Shenoy opted for a third major field – "Software-Based Automotive Systems". "I already had experience in control technology, the construction of electronics architectures and simulations."

A certain specialisation is necessary, as the automotive sector has become highly complex in both technological and organisational terms, and it is not possible to go into all of the drive components in detail during the three-semester master's course. "However, in our degree course we teach the required control technology skills and the methods for developing such complex systems, for example in the 'System Design', 'Simulation and Control' or 'Powertrain' mod-

ules," Professor Schindler explains and goes on to say that it is also no longer sufficient for an engineer to master just his or her subsystem or components. "Instead he must be able to define interfaces with other subsystems precisely, to assess possible interactions and to gain a feeling for the function of the overall system of the 'automobile,'" the specialist for vehicle dynamics, active safety, chassis technology and vehicle control systems says.

Basti Anil Shenoy is working in "Advance Engineering" as part of a cooperation with Bosch, and is currently writing his master's thesis. In order to be able to build the cars of the future, he is dealing with simulations, for example when software for control units has to be tested in a motor vehicle. "At Bosch I have a suitable simulation environment with an entire vehicle at my disposal."

Systems developers have to communicate

It is not only technical skills that are required, however. "Today systems developers have to communicate far more," Professor Schindler continues. Lectures such as "Global Engineering" or "International Negotiations" and interdisciplinary and intercultural projects therefore impart management skills and social competence.

Basti Anil Shenoy's good German language skills helped him to find his way at Bosch: "Even though English is the working language in international teams, I made the experience that German is very important if you want to work in a German firm."



Basti Anil Shenoy comes from India and is studying on the master's course "Automotive Systems" at Esslingen University of Applied Sciences.



Students at the Esslingen University of Applied Sciences prepare measurement devices in a vehicle.



In the project "Fraunhofer System Research on Electric-Powered Mobility" the AutoTram® served as a research platform.

His plans for the future? "First I want to work in Germany for a few more years and gather occupational experience, as Germany is the world leader in automotive engineering. In about five years' time I'll go back to India and work there," the young engineer tells us. In reply to the question about what kind of car he will buy himself one day, he says, quite concisely: "A German car, I think." Professor Schindler knows the career opportunities for the graduates of the master's course: "Our graduates mainly work in the automotive industry and the automotive supplier industry as well as in engineering services. Their primary activities are in development and applications for innovative control and assistance systems in the fields of chassis, drive and complete vehicle. Our Indian and Chinese graduates are also often

recruited by subsidiaries of German automotive firms and their supplier companies in their home countries."

Electromobility – more than building cars

By 2020 there should be a million electric cars on Germany's roads according to the German federal government's plans. In order to achieve this ambitious aim we need not only suitable academic specialists, drive concepts and powerful energy storage devices, but also the corresponding infrastructure, for example for producing and distributing the energy, or facilities to make it possible to "fill up" with power.

The scientists in the large-scale project "Fraunhofer System Research on Electric-Powered Mobility" have been working on the

mobility of the future for many years. Among other things they look at the entire energy path, from the generation of electrical power and its distribution through to its conversion into mechanical energy in the vehicle. In another area of focus they look into the question of how electric-powered vehicles, such as the AutoTram®, can be integrated into today's transport and production systems. This also enables us to recognise the market prospects of and the obstacles to electromobility in Germany. The researchers are not only interested in electric cars for individual transport but also vehicles for local public transport or inner-city goods transport. The Fraunhofer project is intended to help the German automotive industry to secure a top position in this field throughout the world in the long term.



INFORMATION

Esslingen University of Applied Sciences

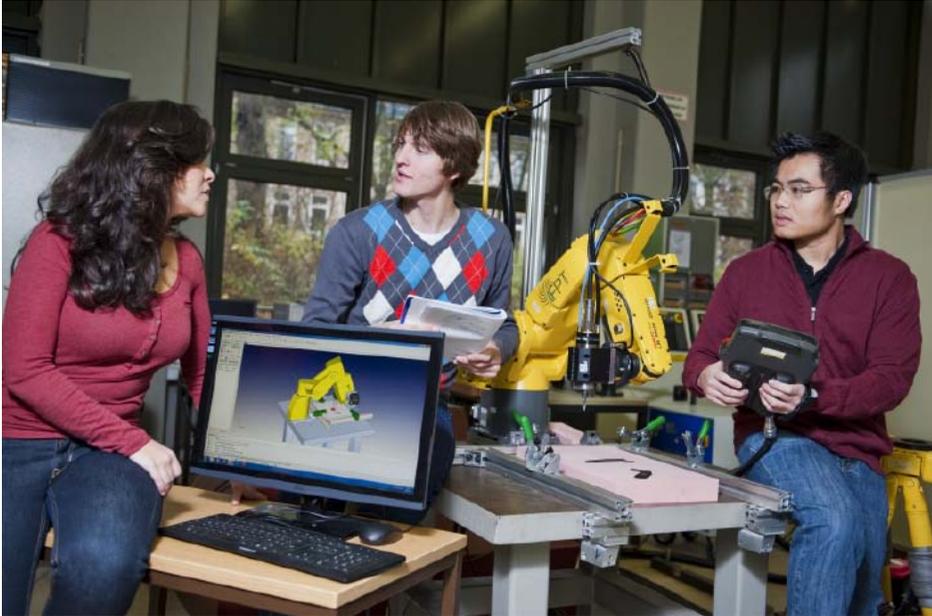
The Graduate School Faculty was founded in 1999 and offers three international master's programmes which are taught in English: an M.Eng. in Automotive Systems, an M.Eng. in Design and Development in Mechanical and Automotive Engineering and an MBA in International Industrial Management. In 2011 there are about 800 alumni from 68 countries.
www.graduate-school.de;
www.hs-esslingen.de

Fraunhofer-Gesellschaft

Fraunhofer is the largest organisation for applied research in Europe and has more than 18,000 employees, most of them with an education in the natural sciences or in engineering. 33 Fraunhofer Institutes have joined together in the project "Fraunhofer System Research on Electric-Powered Mobility" and are putting their expertise into the project in order to take electromobility forward.
www.fraunhofer.de

Making technology clever

The CD drive in a computer, the electronic stability program (ESP) in a car or robots in industrial manufacturing are just a few examples of mechatronics products. In order to be able to develop and manufacture them, engineers are needed who can integrate knowledge from mechanical and electrical engineering and information technology. They are trained in the interdisciplinary master's course in mechatronics.



In "lead-through programming" robots are trained using hand and voice. The control software converts movements and spoken commands into a programme.

His interest in automotive engineering and the good reputation of Germany's automotive industry gave Manpreet S. Saini from India the idea in 2010 of enrolling on the English-speaking master's course in mechatronics at the University of Applied Sciences Ravensburg-Weingarten. He was spoilt for choice, as anyone wanting to study mechatronics in Germany has to opt for one of 100 bachelor's courses or 40 master's courses. Some of the master's courses continue the generalist training begun in the bachelor's degree course. Others make it possible to specialise, with different points of

focus, for example in automotive engineering, medical engineering or robotics.

Embedded systems ensure safe driving

Manpreet S. Saini's passion is for vehicle construction and the "embedded systems" used there, which monitor and control numerous functions in the car. Sensors, mechanics and electronic hardware and software work together in these systems. For example, an ESP control unit receives information from sensors about the wheel speed and the lateral acceleration of the vehicle and regulates

hydraulic valves as needed, which apply brake force to the individual wheels in such a way as to prevent the vehicle from skidding.

Manpreet S. Saini is currently working on his master's thesis in the research and development department of Marquardt GmbH, a developer and manufacturer of switches and switching systems which is active internationally. The student praises the links between the university of applied sciences and industry: "I find it good that our professors have close contacts to the automotive industry and to other firms in that field." His final thesis is in the subject areas of "engi-

Manpreet S. Saini comes from India and is studying mechatronics at the University of Applied Sciences Ravensburg-Weingarten.





Professor Hubert Roth holds the Chair of the Institute of Automatic Control Engineering at the University of Siegen.



neering design" and "software development". "I am dealing with the conceptual design of mechanical parts – to be more precise, with switches and the way that they are connected to the electronic control unit of the car and how they communicate with it," Manpreet S. Saini says to explain his research project.

Courses in English

"We also learn a lot about modern robot systems, their components and their motion control. There are laboratories available for us where we can familiarise ourselves with the robot applications used in industry." And another advantage of the degree course is that it is taught entirely in English. Manpreet S. Saini knows that basic German language skills are very useful nonetheless. The university therefore offers German language courses free of charge before the lecture period begins.

Manpreet S. Saini praises the support which made it easy for him to get started as a student: "The professors take a lot of time for the students and are always available for questions. I also got good tips and support from the student union (Studentenwerk) and the International Office at the university."

The four-semester international master's course in mechatronics at the University of Siegen is also directed specifically at foreign students. "The courses at German universities have to position themselves in the national and international competition," head of graduate studies Professor Hubert Roth says, explaining the motive for creating an English-language degree course, and adds, "however, this course also gives German students the opportunity to gain an advantage with international firms."

The interdisciplinary degree course is conducted jointly by the Department of Electrical Engineering and Computer Science and the Department of Mechanical Engineering. "Our specialist fields are automation, robotics, materials science and control engineering," Professor Roth tells us, summarising the thematic orientation of the degree course.

Robots explore their surroundings

Ahmad Kamal Nasir is particularly taken with robotics. He has just completed the master's degree in mechatronics and is now working towards a doctorate in the field of mobile robotics. Robots that act independently exist not only in the form of mars exploration equipment such as the rover "Opportunity",

but can already be found in many factories, where they take on transport and logistics tasks, for example. Mobile robots need above all information about their own position and about obstacles around them. "The use of autonomous robots for exploring and mapping the environment is the main focus of my research work," the newly qualified master of science says, summarising his field of work.

As far as job prospects are concerned, graduates from Siegen can look into the future optimistically. "Owing to the broad spectrum of the training, mechatronics engineers find jobs both in large corporations and in small and medium-sized firms," Professor Roth tells us, describing his students' employment prospects.

Ahmad Kamal Nasir already has definite plans for the future at any rate: "After completing my doctorate I would like to go into research and development in the field of mobile indoor/outdoor robotics applications in the private sector." He appears to be well equipped for that, as both autonomous outdoor robots, which are used, for example, in the case of serious accidents in open terrain, and driverless transport systems, which serve to optimise the material flow in factories, have to be able to explore and map their surroundings independently.



Ahmad Kamal Nasir comes from Pakistan and is a doctoral student at the Institute of Automatic Control Engineering at the University of Siegen.

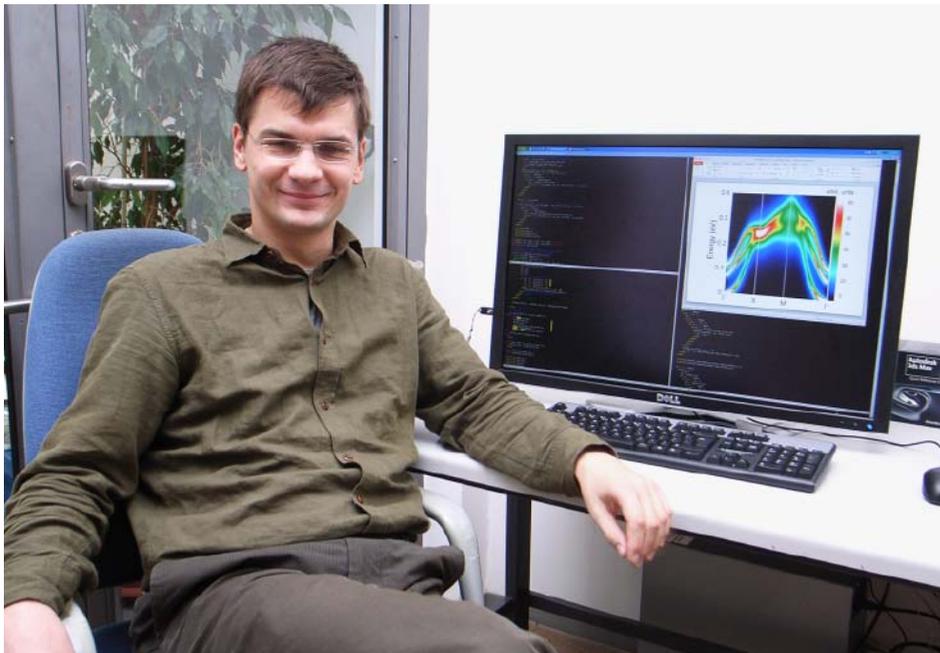
INFORMATION

**University of Applied Sciences
Ravensburg-Weingarten – Master's
course in Mechatronics**
www.hs-weingarten.de/web/masterstudengang-mechatronics

**University of Siegen – International
Graduate Studies in Mechatronics**
www2.uni-siegen.de/mechatronics

“Constructions” measuring a billionth of a metre

When ideas from basic research are to be converted into new types of technologies and marketable products, talented junior scientists are needed. Dr Pawel Buczek from Poland is one of them. With his dissertation on the magnetic properties of nanostructured metals at the International Max Planck Research School for Science and Technology of Nanostructures in Halle he paved the way for his academic career.



Dr Pawel Buczek comes from Poland and gained a doctorate from the IMPRS for Science and Technology of Nanostructures. His monitor shows the visualisation of a spin-wave spectrum of three monolayers of iron on a copper surface.

Minute magnetic particles measuring only a few nanometres have a big effect. Not only scientists like Dr Pawel Buczek realised that long ago. Industry, too, has a considerable interest in the discoveries made in nanotechnology, because technical products can be equipped with ever smaller components and new material properties. For example, computers are to be made more powerful and more efficient by means of tiny magnetic memories that continue to store the data which have been fed in even after the power has been switched off.

“The advantage of the magnetic memory is that it is non-volatile. That would save us the annoying process of loading the operating system when we switch on our PC,” Dr Buczek says, explaining the advantages of the Magnetoresistive Random Access Memory (MRAM) technology. As the post-doctoral researcher knows from his own experience, “in order to develop technologies of this kind

it is important for engineering scientists to understand the nature of atomic particles.”

Thanks to SPEELS

That is why the 30-year-old scientist sees his decision to do his doctorate in Halle as the best decision of his life. “Solid state physics is the institute’s specialist field and at the same time the field in which I want to advance further,” he tells us, explaining his motivation. Another point in favour of doing doctoral studies at the Research School in Halle was the excellent technical facilities: “Thanks to SPEELS (spin-polarized electron energy loss spectroscopy), a special piece of equipment that makes magnetic excitations in microstructures visible, I was able to confirm our theoretical predictions.”

Dr Buczek sees the intensive examination of the research subject as one of the biggest plus points of doing a doctorate in Germany: “I was able to concentrate fully on my re-

search and choose the lectures and seminars that I wanted to attend.” He particularly enjoyed going to the presentation seminars organised by the IMPRS doctoral students themselves: “Every week I learnt a lot about presentation techniques there and was able to benefit from the experiences made by the other doctoral students,” the scientist reports, looking back.

The post-doctoral researcher has three years of intensive research behind him, with a workload of 40 to 60 hours per week. And the scientist’s thirst for research has not yet been quenched. At the beginning of 2012 Dr Buczek will therefore continue his work in Missouri and New York on a Feodor Lynen Research Fellowship from the Alexander von Humboldt Foundation. Shaped by the multicultural society in Upper Silesia, the region where he grew up, the 30-year-old knows that “experience abroad and intercultural competence are important if you want to have international success as a scientist.”



INFORMATION

International Max Planck Research School for Science and Technology of Nanostructures

offers a three-year doctoral scholarship in the field of nanostructure physics
www.nano-imprs.mpg.de

Computational Engineering Science (CES) at the AICES graduate school

Simulating saves money

Time and money are very important in industry. When different variants of a product are tested quickly and inexpensively already during the design phase, computer simulations are used. Innovative modelling approaches and simulation concepts based on them are also developed and optimised at the Aachen Institute for Advanced Study in Computational Engineering Science (AICES). Interdisciplinary know-how is the trademark of the qualified junior scientists.



The AICES team is discussing the simulation of a blood pump, which is being projected onto the so-called "Powerwall" for that purpose.

"In order to predict the behaviour of a car with, for example, larger tyres, we take known parameters such as speed, air temperature and the geometric form of the vehicle, and simulate the changes on the computer. If the result does not yet correspond to the predefined specification, the geometry of the model is modified and the process begins again," Dr Arianna Bosco says, explaining the principle of a computer simulation.

During her three-year doctoral studies, however, the AICES graduate also conducted research into technologies of quite a different kind of vehicle. In an international project team of the German Research Foundation (Deutsche Forschungsgemeinschaft

- DFG) the Italian student worked with her colleagues on the development of a supersonic combustion ramjet engine for future hypersonic space transportation systems, the so-called Scramjet.

Conducting experiments in the wind tunnel

It is therefore not surprising that the 28-year-old has been putting her know-how into the construction of new engines for aviation since gaining her doctorate. The young scientist is at the start of her career and likes to look back at her time at the graduate school: "I am very grateful for the excellent training. AICES gave me the opportunity to put my methodological skills into practice and to observe fascinating phenomena." During her experiments in a wind tunnel the post-doctoral researcher gained important information about aerodynamic effects, which she can use today at the engine manufacturing company MTU Aero Engines in Munich.

Professor Marek Behr, the scientific director and coordinator of the graduate school, also reports about the successful career starts of post-doctoral researchers from AICES: "From Toulouse to Boston, from researchers to managers: our graduates work all over the world at renowned scientific institutes and in industry"

An important factor for this success, according to the professor, is in particular the intensive specialist guidance in small research groups and the international orientation of the graduate school. Approximately 50 percent of the doctoral students are from abroad. In addition to sound specialist skills, excellent English-language skills are important for admission. "If you want to be part of the international research community, English is a basic prerequisite," Professor Behr emphasises.

Intelligent simulations in demand

The director of the Aachen graduate school is convinced of the future potential of the Computational Engineering Science (CES) technologies: "In the ever expanding fields of engineering, there is a growing demand for intelligent and innovative computer simulation approaches. They are based in particular on solving inverse problems, such as the identification of models or optimum design." Professor Behr is certain: "Graduates of Computational Engineering Science have the necessary skills from all the included disciplines: engineering, mathematics and information technology."



INFORMATION

Aachen Institute for Advanced Study in Computational Engineering Science (AICES)

www.aices.rwth-aachen.de



Dr Arianna Bosco comes from Italy and gained a doctorate from the Aachen Institute for Advanced Study in Computational Engineering Science (AICES).

Crisis-proof and multifaceted

Engineers are urgently needed in almost all sectors of the economy for shaping the world in technological terms. Technical specialists trained in Germany enjoy an excellent reputation internationally and are envied for their practical orientation. Dr Willi Fuchs, the director of the Association of German Engineers (Verein Deutscher Ingenieure – VDI) regards the engineering profession not only as multifaceted but also as absolutely crisis-proof.



In manufacturing, mechanical engineers are responsible for developing, maintaining and programming machinery and installations.

According to the “VDI-Ingenieurmonitor” (“VDI Engineering Monitor”), the number of unemployed engineers fell further in September 2011. “This new drop indicates that the shortage of engineers is likely to continue to intensify,” Dr Willi Fuchs says, interpreting the underlying statistics from the Federal Employment Agency (Bundesagentur für Arbeit – BA) and the VDI. “The average age of all German engineers is 51. In the next ten to 15 years many of them will therefore leave the labour market for age-related reasons,” the VDI director warns. A growing lack of engineers could thus even slow down the dynamics of the German economy.

Well paid

Engineers’ salaries are currently rising, as can be seen from a recent salary survey conducted by Kienbaum management consultancy. The firms surveyed expect a 4.1 percent increase in salaries for 2012. According to Kienbaum, an engineer in a managerial position earned an average of € 106,000 in 2011. A specialist was paid a salary of € 63,000 on average.

In 2011 the labour market report of the Federal Employment Agency ascertained that in Germany “the number of employees covered by social security in engineering occupations even rose slightly in the crisis year of 2009 compared with the previous year.” However, the engineering profession has not only proved to be crisis-proof in the short-term, as Dr Fuchs can verify: “In the last 20 years the unemployment rate among engineers has always been below the average rate for all other occupations, and currently stands at less than three percent. That is virtually full employment. What should be taken into account in particular is the fact that only a quarter of all unemployed engineers are out of work for longer than a year.” This is an outstanding starting position, for applicants from abroad, too.

Mechanical and electrical engineers wanted above all

Demand for mechanical, automotive and production engineers in particular rose in 2011. In addition, a considerable increase in the employment of electrical engineers was recorded. The number of engineering

managers in employment had been rising continuously since the start of the millennium. In the case of civil engineers and architects, however, a slight loss of jobs is expected in the long term. In 2009 about one tenth (approx. 150,000) of all engineers were self-employed or working on a freelance basis. The typical form of self-employment is still the engineering or expert office. Spin-offs out of the universities are gaining importance.

Engineers find jobs in almost all economic sectors in Germany. In recent years they have been sought above all in the automotive industry, for the manufacture of IT equipment and electronic and optical products, by management consultancies, in the wholesale trade and for the manufacture of metal products. Especially in mechanical and plant engineering firms and in the electrical industry recent graduates are welcomed with open arms – for a wide variety of functions in fact. VDI director Dr Fuchs emphasises that the focus is not only on research and development (R&D) tasks: “R&D and production go hand in hand. For example, electromobility: while some of the engineers are developing energy

The engineering labour market – an overview

	Employees covered by social security 2009	% change on previous year	Unemployed in 2009 (annual average)	% change on previous year
Agricultural engineers, engineers in garden and landscape development, forest engineers	11,700	+ 2.6	2,000	- 12
Mechanical and automotive engineers	153,000	- 1.1	5,400	+ 31
Electrical engineers	156,000	- 2.6	3,800	+ 19
Architects, civil engineers	122,900	+ 1.3	8,100	- 2
Surveyors	9,200	- 0.5	400	- 9
Mining, steel and foundry engineers	5,600	- 2.0	500	+ 3
Other manufacturing engineers	26,000	- 2.8	1,200	+ 10
Marine engineers, flight engineers	5,800	- 2.6	100	+ 32
Other engineers	217,500	+ 5.2	6,600	+ 56
of which: engineering managers	-	-	2,600	+ 44
Chemists, chemical engineers	41,200	+ 0.5	2,500	+ 7
Physicists, engineering physicists, mathematicians	23,900	+ 1.0	1,500	+ 5
Engineers overall	774,900	+ 1.2	32,100	+ 15
Graduate labour market	2,858,800	+ 3.5	161,200	x
Labour market overall	27,380,100	- 0.3	3,139,800	+ 6

x no data available

Data source: statistics of the German Federal Employment Agency (Bundesagentur für Arbeit)

career level there are hardly any alternatives when filling vacancies: engineers invariably hold managerial positions such as head of development, construction or production.

“Anyone wanting to practise the occupation of an engineer has to possess technical competence,” Willi Fuchs emphasises. In addition, systematic and solution-oriented working methods are required in industry. An ability to think both in analytical and in conceptual terms is also necessary for this, he tells us. “System-oriented, able to work in a team, interdisciplinary and flexible,” is how the VDI director characterises a successful engineer who is increasingly involved in complex system contexts and international networks. For this reason communication skills are gaining in importance. Foreign language skills are indispensable due to the international links in the world economy; command of at least the technical global language of English is a must.

A lack of female engineers

Firms would like to exploit the potential of female engineers to a greater extent: according to statistics from the Federal Employment Agency only 104,800 female engineers were employed in 2009. The proportion of women is therefore just under 14 percent. Thanks to promotion programmes created by the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung – BMBF), the VDI and large companies, the figure has thus risen by a good two percentage points since the start of the millennium. VDI director Willi Fuchs does not want to call this a success story yet, though. There are numerous projects and initiatives aimed at getting female pupils interested in degree courses in the natural sciences and technology, however: “Go MINT” is the motto of the National Pact for Women in MINT Careers (Mathematics, Informatics, Natural sciences, Technology).

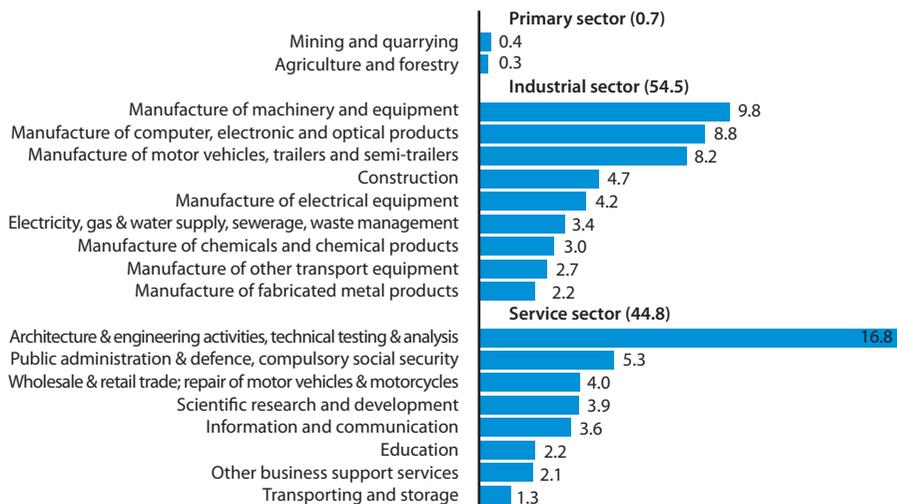
INFORMATION

Association of German Engineers (Ver- ein Deutscher Ingenieure e.V. – VDI)

With its more than 140,000 members, the Association of German Engineers is one of the largest technical-scientific associations in Europe. As a non-profit and independent organisation it is the central contact point for technical, occupational and political questions. www.vdi.de

The majority of engineering specialists work in the industrial sector

employees covered by social security, by economic sector, shares as percentages, June 2009



Data source: statistics of the German Federal Employment Agency (Bundesagentur für Arbeit)

storage devices, others are considering how production will have to be reorganised.”

Manufacturing remains a domain of engineers. For example, they plan and assemble production lines or monitor production as quality assurance representatives. In construction they design buildings, machines or equipment with the aid of computers. In technical purchasing they procure construction materials, in technical sales and distribution they are responsible for advising customers and for selling and launching products. Technical specialists can also be found in marketing, even if the thought of

wanting to sell a product does not necessarily correspond to an engineer’s typical thinking. “They want to fathom a problem and then solve it,” Willi Fuchs tells us, describing his colleagues.

Career as a specialist or a manager?

“An engineer has to decide whether he wants to pursue a specialist or a management career,” VDI director Willi Fuchs points out. “Generally there is at least one engineer on the managing board of a firm, and CEOs with this type of educational background are becoming more and more common.” At the specialist

Managing projects in the wind

Julien Berbach comes from Alsace. Yet it was not the geographical proximity that brought him to Germany, but an interesting job offer. At Siemens Wind Power the French aerospace engineer took a big step into the project management of a communication and control network.



Assembly of a gearless wind turbine – hardly any manual intervention is necessary once the SCADA communication and control software is up and running.

In aerospace engineering Julien Berbach was especially fascinated in the electronic control of machines and systems engineering, which concerns the coordination of complex technical projects. At Siemens Wind Power the French engineer has now ventured fully onto the management level. The task of the 37-year-old: to equip wind farms all over the world with the customised control and monitoring system SCADA.

SCADA can be pictured as a network of several computers that provides for communication between the wind farm and Siemens, and helps the wind farm operators to control their wind turbines. All operating events and data are recorded and analysed in the form of statistics. This means that

wind speeds, the performance of the wind turbines and possible faults can be tracked at any time, even from Hamburg.

Between sales managers and computer scientists

Julien Berbach's arrival in Hamburg was a "soft landing". "I did German at school and as an Alsatian I am familiar with the culture here. The Germans that I have got to know – and not only those at work – are open for people from other countries and are interested in their cultures." What he likes at his place of work is the friendly atmosphere: "You hardly feel the hierarchies. This means that I can work independently and take on responsibility."

With a touch of irony Julien Berbach defines his job profile as a "data collector". They are not only technical data as one could assume in the case of an engineer, however. He also has to translate customers' wishes into the language of technology, which would not be possible without an engineering background. "On the customer side I have a lot to do with sales people," Julien Berbach explains, "whereas within the firm I mainly have to explain to computer scientists how SCADA is to be programmed in each particular case."

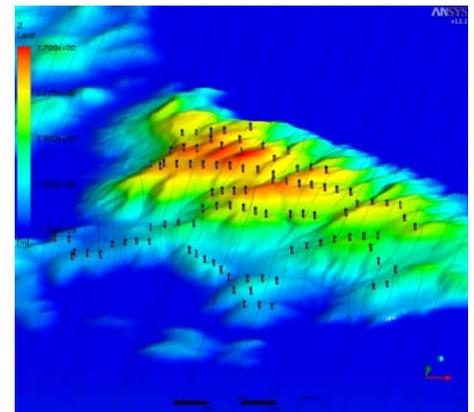


Julien Berbach studied aerospace engineering and is a project manager at Siemens Wind Power.

Being the driving force

The engineer from Alsace demonstrates his communication skills in the coordination between the participating wind farm and network operators. For example if the noise level of a wind turbine has to be minimised for noise protection reasons and therefore a loss of output has to be accepted. "We have to rely on precise information here," Julien Berbach says, describing one of many possible problem situations. He also tells us that the partners often do not realise what information is required for SCADA to be adjusted optimally. As a driving force the French project manager is always busy gathering this information and harmonising it with the time schedules.

Finally, documentation is also a matter for the boss: "I have to ensure that all test reports and user manuals are contained and that the descriptions are written in line with customer needs," explains Julien Berbach, who would like to continue his career at Siemens.



New software developed by Siemens is intended to improve the energy output of a wind farm and to extend its operating time. To this end the behaviour of an entire wind farm is simulated and the performance of the individual turbines is coordinated.

INFORMATION

Siemens Wind Power
www.siemens.com/wind

Engineers in industry

Linking knowledge creatively

The Bosch Group recruited some 9,000 graduates in 2011, 1,200 of them in Germany. About 80 percent of these new recruits are engineers, scientists or IT specialists. Jörn Kleine is the head of "Recruiting Elektromobilität" and knows that engineers in industry are expected to be solution-oriented, flexible and willing to continue their training continuously.



Bosch supplies engines for hybrid and electric vehicles as well as the relevant power electronics, presented here by a junior development engineer.

In the current debate surrounding the recruitment of engineers, one could gain the impression that soft skills are almost more highly valued than specialist skills. What is the situation at Bosch?

At Bosch a good degree and sound specialist training are right at the top of the list. Personality is also a decisive factor. This is often forgotten in the discussion surrounding soft skills these days. What we consider particularly important is that our staff are solution-oriented. As technical issues are becoming more and more complex, existing knowledge has to be linked creatively. When deciding whether somebody is suitable for Bosch, we are guided by the values of our firm: openness, trust, fairness and a clear belief in cultural diversity. The applicant's personality should also be characterised by these values.

By 'belief in cultural diversity' you surely also mean that foreign assignments or international contacts have become the norm for engineers in the context of accelerated globalisation?

That is an important aspect. We expect our staff to be flexible in terms of time and location, for example for projects in international teams across several time zones. With some 300 subsidiaries and regional companies, Bosch provides opportunities for advancement throughout the world. Our employees can gather international experience in a number of different ways – from short stays in connection with a particular project, to phases lasting several years. Even if they stay in their own country, Bosch employees often work as part of an international network. The company encourages rotation between sectors, business units and corporate divisions as well as between careers (specialist, project management or line management careers). Apart from that we recruit abroad for the respective local market, rarely for the German market. India is in the top position with 3,700 graduates in 2011, followed by China (2,700) and Germany (1,200).

What fields of activity do engineers work in at Bosch and what support do they receive during the familiarisation phase?

The list is long there. There are diverse opportunities in almost all functional areas. In the business unit Gasoline Systems for instance, which includes the field of electromobility, we seek experts for research and development, application, construction, manufacturing, logistics, quality management or technical sales. In the eMobility field there will be demand in particular for more electrochemists (battery) and IT specialists (control and linking of the products, keyword "Internet of Things") in the future.

We have developed a standardised familiarisation programme, for example in the hybrid unit, which familiarises new employees with all the important topics of electromobility. This programme is supplemented by an individual familiarisation plan, which takes into account the new recruit's particular field of activity.



Jörn Kleine is the head of "Recruiting Elektromobilität" at the Bosch Group.

INFORMATION

The Bosch Group invests € 400 million per year in the **Electromobility** business unit, some 800 members of staff are employed in research and development for hybrid and electric vehicle technologies. In addition to that there are about 900 employees in the joint venture SB LiMotive, who are developing lithium-ion battery technology for applications that will be used in future in electric cars made for instance by Fiat or BMW.

The Bosch career website

www.bosch-career.de

Optical technologies

Light – a future-oriented sector

Without really being aware of them, we come across optical technologies every day, for instance when we are driving the car, surfing the Internet or listening to music. They are regarded as the drivers of innovation in the 21st century. And in Germany they are a growth industry which is very popular at international level. Talented young people are sought in order to maintain the competitive edge in terms of knowledge on the global market.



The doctoral student Nguyen Xuan Truong from Vietnam is conducting research in the field of laser technology, nonlinear optics and cluster physics at the University of Rostock.

The science of light, also known as photonics or optoelectronics, is permeating more and more areas of life: when we are on the telephone we use smartphones with touchscreens and LED flashlights. In the car, windscreen wiper sensors automatically adjust the speed of the wipers to the amount of rain. When we surf the Internet, data are converted into light signals and are sent from one place to another in a matter of seconds via the optical fibre network. "This would not be possible without the tool of light," Dr Thomas Fahlbusch, managing director of the Competence Network 'PhotonicNet', points out.

Photonics therefore deals with all physical and biological technologies that produce,

control and harness light of all wavelength ranges. It delivers important impetus for energy-efficient production processes, for resource-conserving energy and environmental technology or for more precise diagnosis and treatment methods in medicine. "And all that always has to be smaller, faster, more powerful and cheaper," Dr Fahlbusch tells us, putting his finger on one of the biggest challenges of the sector.

Anyone who opts for a career in the field of optical technologies today shows foresight. The "future-oriented sector of light" occupies a key position: mechanical, automotive, marine and aviation engineering, power engineering, lighting technology, medical engineering, environmental engineering, information and communication technology rely on the innovations of this sector.

Networking as a locational advantage

Germany is way ahead in the global race for know-how. The proportion of German firms in leading markets such as life sciences or lighting is over 17 percent, with about € 22 billion, and the trend is increasing. In the next ten years German firms want to invest some € 30 billion in research and develop-

ment. "One important locational advantage is the hitherto unique, strongly networked infrastructure in research and development," Dr Fahlbusch emphasises. "Clusters of excellence and projects that unite the universities and renowned research institutions with the companies are particularly promising."

Engineers who are keen to experiment

In order to stimulate the innovative force still further, 20,000 new jobs are to be created in the photonics sector by the year 2015. In Germany there are vacancies in particular for young engineers of various disciplines such as mechanical and electrical engineering, nanotechnology or materials sciences. "The many facets of the supplier markets are reflected in the engineers' fields of work," Daniela Waterböhr from the industry association SPECTARIS explains. "Firms welcome generalists – such as mechanical engineers. But applicants with special skills, for example in satellite control, also have good opportunities in this sector." In Daniela Waterböhr's opinion there is no clearly defined occupational profile: "An interest in technology, a love of experimenting and team spirit are important ingredients for a career in optical technologies, however."

INFORMATION

Competence Network PhotonicNET is a partnership of representatives from industry, research, education and politics and is aimed at promoting optical technologies.
www.photonicnet.de

The SPECTARIS industry association founded the Light Alliance Initiative together with eleven German firms in optical technologies. Future trends and career opportunities in the photonics sector are presented in the Internet portal.
www.lightalliance.de



Dr Thomas Fahlbusch is the managing director of the Competence Network 'PhotonicNet'.

Important links at a glance

Preparation and overview of degree courses www.study-in.de

First information about living and studying in Germany, with videos, chat forums, reports from foreign students, city portraits and a database of all degree courses

www.daad.de

Website of the German Academic Exchange Service (Deutscher Akademischer Austauschdienst – DAAD): more detailed information regarding first degree courses and doctoral studies in Germany
www.daad.de/international-programmes

Possibility to search for internationally recognised, accredited bachelor's, master's and doctoral programmes at German universities, most of them taught in English

www.daad.de/ez-aufbaustudiengaenge

List of postgraduate courses with relevance to developing countries for young professionals from developing countries

www.hochschulkompass.de

Information portal of the German Rectors' Conference (Hochschulrektorenkonferenz – HRK) with information on German higher education institutions, their courses and opportunities for doctoral studies, as well as international cooperations

www.think-ing.de

Information platform for engineering occupations
<http://studieninfo.ftmv.de>

Degree course information system provided by the Association of Mechanical Process Engineering Faculties (Fakultätentag für Maschinenbau und Verfahrenstechnik – TMV)

www.techportal.de

Information portal about degree courses in innovative fields of technology (nanotechnology, surfaces, plasma, superconductivity, materials)

Support and service

www.internationale-studierende.de

Information portal of the 58 student unions (Studentenwerke) in Germany with information about economic, social, health and cultural support for international students at German universities

www.daad.de/aaa

Addresses of the International Offices (Akademische Auslandsämter – AAA) at the German universities

Application, admission

www.daad.de/admission

This page provides information about which educational certificates obtained outside Germany are required for admission to higher education in Germany.

www.anabin.de

Information system for the recognition of foreign educational qualifications run by the Central Office for Foreign Education Systems (Zentralstelle für Ausländisches Bildungswesen – ZAB)

www.uni-assist.de

Internet portal of the University Application

Service for International Students (Arbeits- und Servicestelle für ausländische Studienbewerber)

Engineering at the universities

www.4ing.net

4ING is the umbrella organisation of the Associations of the Engineering and Information Technology Faculties at Universities (Fakultätentage der Ingenieurwissenschaften und der Informatik an Universitäten).

www.tu9.de

TU9 is the alliance of the leading institutes of technology in Germany.

Scientific organisations, networks

www.dfg.de

German Research Foundation (Deutsche Forschungsgemeinschaft – DFG)

www.research-explorer.de

Research explorer of the DAAD and the DFG

www.helmholtz.de

Helmholtz Association (Helmholtz-Gemeinschaft)

www.mpg.de

Max Planck Society (Max-Planck-Gesellschaft)

www.fraunhofer.de

Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. is an application-oriented research organisation.

Funding

www.funding-guide.de

Database of scholarships offered by the DAAD and other funding organisations

Associations, organisations

www.vdi.de

Association of German Engineers (Verein Deutscher Ingenieure e.V.)

www.bingk.de

The Federal Chamber of Engineers (Bundesingenieurkammer) represents the collective interests of its member chambers at national and European level.

www.vde.com

Association for Electrical, Electronic & Information Technologies (VDE Verband der Elektrotechnik Elektronik Informationstechnik e.V.)

www.zvei.org

German Electrical and Electronic Manufacturers' Association (ZVEI – Zentralverband Elektrotechnik- und Elektronikindustrie e.V.)

www.bitkom.org

BITKOM Federal Association for Information Technology, Telecommunications and New Media (BITKOM Bundesverband Informationswirtschaft, Telekommunikation und neue Medien e.V.)

www.vdma.org

VDMA German Engineering Federation (VDMA Verband Deutscher Maschinen- und Anlagenbau e.V.)

www.vda.de

German Association of the Automotive Industry (Verband der Automobilindustrie e. V. – VDA)

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“New energy for the future.”

Baris Karacay from Turkey studies electrical engineering at RWTH Aachen University.



The picture was taken at a charging station in front of the SuperC building at RWTH Aachen University.

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